NUREG-0800
(Formerly NUREG-75/087)

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

3.6.2 DETERMINATION OF RUPTURE LOCATIONS AND DYNAMIC EFFECTS ASSOCIATED WITH THE POSTULATED RUPTURE OF PIPING

REVIEW RESPONSIBILITIES

Primary - Mechanical Engineering Branch (EMEB)[1]

Secondary - None

I. AREAS OF REVIEW

General Design Criterion 4 (GDC 4)[2] ~~(Ref. 1)~~[3] requires that structures, systems, and components important to safety shall be designed to accommodate the effects of postulated accidents, including appropriate protection against the dynamic and environmental effects of postulated pipe ruptures.

Information concerning break and crack location criteria and methods of analysis for evaluating the dynamic effects associated with postulated breaks and cracks in high- and moderate-energy fluid system piping, including "field run" piping, inside and outside of containment should be provided in the applicant's safety analysis report (SAR). This information is reviewed by the EMEB[4] in accordance with this Standard Review Plan (SRP,[5] section to confirm that requirements for the protection of structures, systems, and components relied upon for safe reactor shutdown or to mitigate the consequences of a postulated pipe rupture are met.

At the construction permit (CP) stage, the staff review covers the following specific areas:

1. The criteria used to define break and crack locations and configurations.

2. The analytical methods used to define the forcing functions, including the jet thrust reaction at the postulated pipe break or crack location and jet impingement loadings on adjacent safety-related structures, systems, and components.

3. The dynamic analysis methods used to verify the integrity and operability of mechanical components, component supports, and piping systems, including restraints and other protective devices, under postulated pipe rupture loads.

At the operating license (OL) stage, the staff review covers the following specific areas:

~~1~~A.[6] The implementation of criteria for defining pipe break and crack locations and configurations.

~~2~~B. The implementation of criteria dealing with special features, such as augmented inservice inspection programs or the use of special protective devices such as pipe-whip restraints, including diagrams showing final configurations, locations, and orientations in relation to break locations in each piping system.

~~3~~C. The acceptability of the analysis results, including the jet thrust and impingement forcing functions and pipe-whip dynamic effects.

~~4~~D. The design adequacy of systems, components, and component supports to ~~assure~~ensure[7] that the intended design functions will not be impaired to an unacceptable level of integrity or operability as a result of pipe-whip or jet impingement loadings.

Review Interfaces[8]

~~In addition, the MEB~~The EMEB[9] will coordinate other branches' evaluations that interface with the overall review of the plant protection against postulated pipe rupture, as follows:

(1)[10] The ~~Auxiliary Systems Branch (ASB)~~Plant Systems Branch (SPLB)[11] reviews plant arrangements where separation of high- and moderate-energy systems is the method of protection for essential systems and components outside containment in SRP Section 3.6.1. The ~~ASB~~SPLB[12] identifies high- and moderate-energy systems outside containment and the essential systems and components that must be protected from postulated pipe rupture in these high- and moderate-energy systems.

(2) If an applicant proposes to use leak-before-break technology to exclude the dynamic effects of postulated pipe ruptures from the design basis of plant structures, systems, and components, the Materials and Chemical Engineering Branch (EMCB) will review the applicant’s design and analyses as part of its primary review responsibility for SRP Section 3.6.3 (later).[13]

(3) The ~~Structural Engineering Branch (SEB)~~Civil Engineering and Geosciences Branch (ECGB)[14] reviews loading combinations and other design aspects of protective structures of compartments used to protect essential systems and components in SRP Sections 3.8.3 and 3.8.4. The ~~Material Engineering Branch (MTEB)~~ECGB also[15] reviews inservice

inspection and related design provisions of high- and moderate-energy systems in SRP Sections 5.2.4 and 6.6, including those associated with the break exclusion regions.

(4) The Reactor Systems Branch (~~RSB~~SRXB)[16] identifies high- and moderate-energy systems inside containment and the essential systems and components that must be protected from postulated pipe rupture in these high- and moderate-energy systems, such as the emergency core cooling system in SRP Section 6.3.

(5) The ~~Equipment Qualification Branch (EQB)~~SPLB[17] reviews the environmental effects of pipe rupture, such as temperature, humidity, and spray-wetting, with respect to the functional performance of essential electrical equipment and instrumentation in SRP Section 3.11.

(6) The Containment Systems and Severe Accident Branch (SCSB)[18] will verify that piping systems penetrating the containment barrier are designed with acceptable isolation features to maintain containment integrity as part of its primary review responsibility for SRP Section 6.2.4.

For those areas of review identified~~ above as being reviewed~~ as part of the primary~~ review~~ responsibility of another branch, the acceptance criteria~~ necessary for the review~~ and~~ their~~ methods of application are contained in the referenced SRP section~~ of the corresponding primary branch~~.[19]

II. ACCEPTANCE CRITERIA

EMEB[20] acceptance criteria are based on meeting the requirements of ~~General Design Criterion~~GDC[21] 4, as it relates to structures, systems, and components important to safety being designed to accommodate the dynamic effects of postulated pipe rupture, including postulation of pipe rupture locations; break and crack characteristics; dynamic analysis of pipe-whip; and jet impingement loads.

Specific criteria necessary to meet the relevant requirements of GDC 4 are as follows:

1. Postulated Pipe Rupture Locations Inside Containment

   Acceptable criteria to define postulated pipe rupture locations and configurations inside containment are specified in Branch Technical Position (BTP) EMEB 3-1~~ (Ref. 4)~~.[22]

2. Postulated Pipe Rupture Locations Outside Containment

   For protection against postulated pipe ruptures outside containment, BTP EMEB[23] 3-1 provides[24] acceptable criteria to define postulated rupture locations and plant layout considerations.

3. Methods of Analysis

Detailed acceptance criteria covering pipe-whip dynamic analysis, including determination of the forcing functions of jet thrust and jet impingement, are included in subsection III, "Review Procedures," of this SRP section. The general bases and assumptions of the analysis are given in BTP EMEB[25] 3-1, subsection B.3.

Technical Rationale[26]

The technical rationale for application of these acceptance criteria to reviewing the determination of rupture locations and dynamic effects associated with the postulated rupture of piping is discussed in the following paragraphs:[27]

Compliance with GDC 4 requires that nuclear power plant structures, systems, and components important to safety be designed to accommodate the effects of, and be compatible with, environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components are to be protected against pipe-whip and discharging fluids. Such dynamic effects may be excluded from the design basis if the probability of pipe rupture is shown to be extremely low.

Meeting the requirements of GDC 4 provides assurance that safety-related structures, systems, and components will be protected from dynamic effects of pipe-whip and discharging fluids that could result from expected environmental conditions, thereby ensuring their ability to perform their intended safety functions.[28]

III. REVIEW PROCEDURES

The reviewer will select and emphasize material from this SRP section, as may be appropriate for a particular case.

1. The locations and configurations of breaks in high-energy piping and leakage cracks in moderate-energy piping are reviewed.

    a. At the CP stage, the applicant's criteria for determining break and crack locations are reviewed for conformance with the acceptance criteria referenced in subsection II of this SRP section.

        Exceptions taken by the applicant to the referenced pipe break location and configuration criteria must be identified and the basis clearly justified so that evaluation is possible. Deviations from approved criteria and the justifications provided are reviewed to determine acceptability.

    b. At the OL stage, the following are reviewed to ensure that the pipe break criteria have been properly implemented:

        (1) Sketches showing the locations of the resulting postulated pipe ruptures, including identification of longitudinal and circumferential breaks, structural barriers, if any, restraint locations, and the constrained directions in each restraint.

(2) A summary of the data developed to select postulated break locations, including, for each point, the calculated stress intensity, the calculated cumulative usage factor, and the calculated primary plus secondary stress range as delineated in References 2 and 3 and BTP EMEB 3-1.[29]

2. Analyses of pipe motion caused by the dynamic effects of postulated breaks are reviewed. These analyses should show that pipe motions will not be such as to result in unacceptable impact upon, or overstress of, any structure, system, or component important to safety to the extent that essential functions would be impaired or precluded. The analysis methods used should be adequate to determine the resulting loadings in terms of the kinetic energy or momentum induced by the impact of the whipping pipe, if unrestrained, upon a protective barrier or a component important to safety and to determine the dynamic response of the restraints induced by the impact and rebound, if any, of the ruptured pipe.

An unrestrained whipping pipe should be considered capable of causing circumferential and longitudinal breaks, individually, in impacted pipes of smaller nominal pipe size and developing through-wall cracks in equal or larger nominal pipe sizes with thinner wall thickness, except where analytical or experimental, or both, data for the expected range of impact energies demonstrates the capability to withstand the impact without rupture.

At the CP stage, the staff reviews the applicant's criteria, methods, and procedures used or proposed for dynamic analyses by comparing them to the criteria which follow. At the OL stage, the analyses are reviewed in accordance with these criteria.

a. Dynamic Analysis Criteria

An analysis of the dynamic response of the pipe run or branch should be performed for each longitudinal and circumferential postulated piping break.

The loading condition of a pipe run or branch, prior to the postulated rupture, in terms of internal pressure, temperature, and inertial effects should be used in the evaluation for postulated breaks. For piping pressurized during operation at power, the initial condition should be the greater of the contained energy at hot standby or at 102% power.

In the case of a circumferential rupture, the need for a pipe-whip dynamic analysis may be governed by considerations of the available driving energy.

Dynamic analysis methods used for calculating piping and restraint system responses to the jet thrust developed ~~following~~after[30] the postulated rupture should adequately account for the following effects: (a) mass inertia and stiffness properties of the system, (b) impact and rebound, (c) elastic and inelastic deformation of piping and restraints, and (d) support boundary conditions.

If a crushable material, such as honeycomb, is used, the allowable capacity of crushable material shall be limited to 80% of its rated energy dissipating capacity as determined by dynamic testing, at loading rates within ±50% of the specified design loading rate. The rated energy dissipating capacity shall be taken as not greater than the area under the load-deflection curve as illustrated in Figure 3.6.2-1. The portion of the curve in which the value of load vs. deflection has departed from the essentially horizontal portion shall not be used. Pure tension members shall be limited to an allowable strain of 50% of the ultimate uniform strain (X_m) (see Figure 3.6.2-2(a)). Alternatively, the allowable strain value may be determined as the value of strain associated with 50% of the ultimate uniform energy absorption capacity as determined by dynamic testing at loading rates within ±50% of the specified design loading rate (see Figure 3.6.2-2(b)). The method of dynamic analysis used should be capable of determining the inelastic behavior of the piping and restraint system within these design limits.

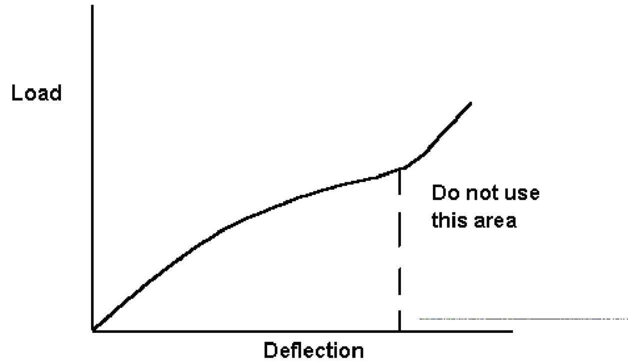

Figure 3.6.2-1 Rated energy dissipating capacity[31]

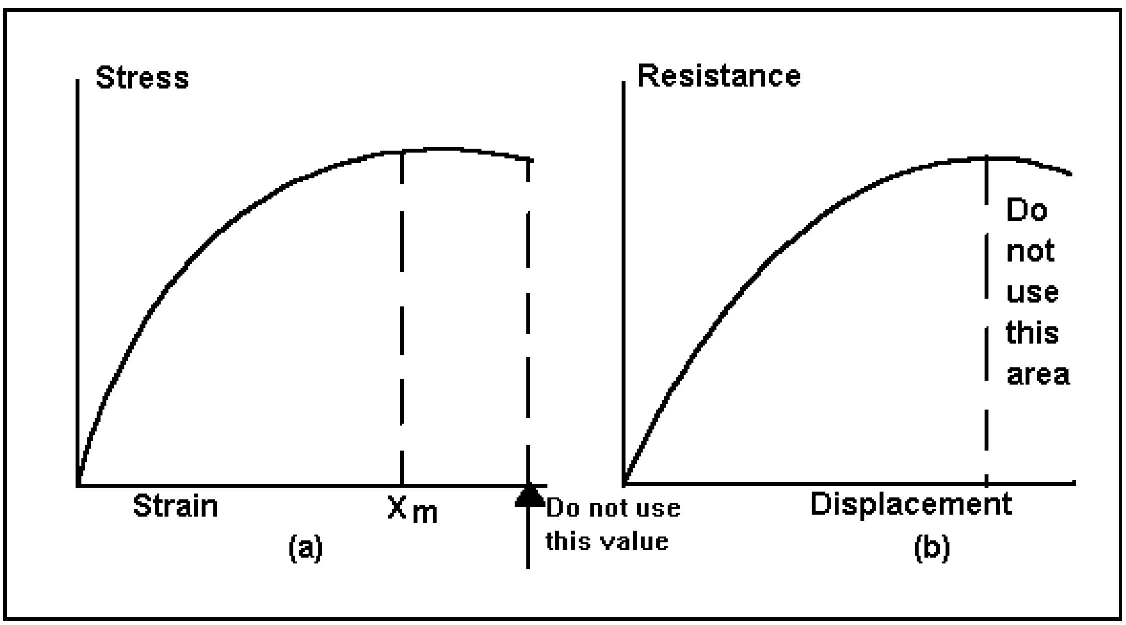

Figure 3.6.2-2 Limitations on pure tension members[32]

A 10% increase of minimum specified design yield strength (S_y) may be used in the analysis to account for strain rate effects.

Dynamic analysis methods and procedures presented should include:

(1) A representative mathematical model of the piping system or piping and restraint system.

(2) The analytical method of solution selected.

(3) Solutions for the most severe responses among the piping breaks analyzed.

(4) Solutions with demonstrable accuracy or justifiable conservatism.

The extent of mathematical modeling and analysis should be governed by the method of analysis selected.

b. Dynamic Analysis Models for Piping Systems

Analysis should be conducted of the postulated ruptured pipe and pipe-whip restraint system response to the fluid dynamic force.

Acceptable models for the analysis of ASME Class 1, 2, and 3 piping systems and other nonsafety-class high-energy piping systems include the following:

(1) Lumped Parameter Analysis Model: Lumped mass points are interconnected by springs to take into account inertia and stiffness properties of the system, and time histories of responses are computed by numerical integration, taking into account clearances at restraints and inelastic effects. In the calculation, the maximum possible initial clearance should be used to account for the most adverse dynamic effects of pipe-whip.

(2) Energy Balance Analysis Model: Kinetic energy generated during the first quarter cycle movement of the rupture pipe and imparted to the piping and restraint system through impact is converted into equivalent strain energy. In the calculation, the maximum possible initial clearance at restraints should be used to account for the most adverse dynamic effects of pipe-whip. Deformations of the pipe and the restraint should be compatible with the level of absorbed energy. The energy absorbed by the pipe deformation may be deducted from the total energy imparted to the system. For applications where pipe rebound may occur upon impact on the restraint, an amplification factor of 1.1 should be used to establish the magnitude of the forcing function in order to determine the maximum reaction force of the restraint beyond the first quarter cycle of response. Amplification factors other than 1.1 may be used if justified by more detailed dynamic analysis.

(3) Static Analysis Model: The jet thrust force is represented by a conservatively amplified static loading, and the ruptured system is analyzed statically. An amplification factor can be used to establish the magnitude of the forcing function. However, the factor should be based on a conservative value obtained by comparison with factors derived from detailed dynamic analyses performed on comparable systems.

(4) Other models may be considered if justified.

c. Dynamic Analysis Models for Jet Thrust Justified.

(1) The time-dependent function representing the thrust force caused by jet flow from a postulated pipe break or crack should include the combined effects of the following: the thrust pulse resulting from the sudden pressure drop at the initial moment of pipe rupture; the thrust transient resulting from wave propagation and reflection; and the blowdown thrust resulting from buildup of the discharge flow rate, which may reach steady state if there is a fluid energy reservoir having sufficient capacity to develop a steady jet for a significant interval. Alternatively, a steady state jet thrust function may be used, as outlined in subsection III.2.c(4), below.

(2) A rise time not exceeding one millisecond should be used for the initial pulse, unless a combined crack propagation time and break opening time greater than one millisecond can be substantiated by experimental data or analytical theory based on dynamic structural response.

(3) The time variation of the jet thrust forcing function should be related to the pressure, enthalpy, and volume of fluid in the upstream reservoir and the capability of the reservoir to supply a high energy flow stream to the break area for a significant interval. The shape of the transient function may be modified by considering the break area and the system flow conditions, the piping friction losses, the flow directional changes, and the application of flow-limiting devices.

(4) The jet thrust force may be represented by a steady state function if the energy balance model or the static model is used in the subsequent pipe motion analysis. In either case, a step function amplified as indicated in subsection III.2.b(2) or III.2.b(3),[33] above, is acceptable. The function should have a magnitude not less than

$$T = KpA$$

where

p = system pressure prior to pipe break,
A = pipe break area, and
K = thrust coefficient.

To be acceptable, K values should not be less than 1.26 for steam, saturated water, or stream-water mixtures or 2.0 for subcooled, nonflashing water.

3. Analyses of jet impingement forces are reviewed. These analyses should show that jet impingement loadings on nearby safety-related structures, systems, and components will

not be such as to impair or preclude essential functions. Assumptions that are acceptable in modeling jet impingement forces are:

a. The jet area expands uniformly at a half angle, not exceeding 10 degrees.

b. The impinging jet proceeds along a straight path.

c. The total impingement force acting on any cross-sectional area of the jet is time and distance invariant, with a total magnitude equivalent to the jet thrust force as defined in subsection III.2.c(4), above.

d. The impingement force is uniformly distributed across the cross-sectional area of the jet, and only the portion intercepted by the target is considered.

e. The break opening may be assumed to be a circular orifice of cross-sectional flow area equal to the effective flow area of the break.

f. Jet expansion within a zone of five pipe diameters from the break location is acceptable if substantiated by a valid analysis or testing, i.e., Moody's expansion model (Ref. 6). However, jet expansion is applicable to steam or water-steam mixtures only and should not be applied to cases of saturated water or subcooled water blowdown.

4. Analyses of pipe break dynamic effects on mechanical components and supports should include the effects of both internal reactor pressure vessel asymmetric pressurization loads and expanded[34] asymmetric compartment pressurization loads, as appropriate, as discussed for pressurized water reactor (PWR)[35] primary systems in Reference 7.

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.[36]

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and that ~~his~~the[37] review supports conclusions of the following type, to be included in the staff's safety evaluation report (SER):[38]

> The staff evaluation concludes that the pipe rupture postulation and the associated effects are adequately considered in the plant design, and therefore are acceptable and meet the requirements of General Design Criterion 4. This conclusion is based on the following:

1. The proposed pipe rupture locations have been adequately assumed and the design of piping restraints and measures to deal with the subsequent dynamic effects of pipe-whip and jet impingement provide adequate protection to the integrity and functionality of safety-related structures, systems, and components.

2. The provisions for protection against dynamic effects associated with pipe ruptures of the reactor coolant pressure boundary inside containment and the resulting discharging fluid provide adequate assurance that design basis loss-of-coolant accidents will not be aggravated by sequential failures of safety-related piping, and emergency core cooling system performance will not be degraded by these dynamic effects.

3. The proposed piping and restraint arrangement and applicable design considerations for high- and moderate-energy fluid systems inside and outside of containment, including the reactor coolant pressure boundary, will provide adequate assurance that the structures, systems, and components important to safety that are in close proximity to the postulated pipe rupture will be protected. The design will be of a nature to mitigate the consequences of pipe ruptures so that the reactor can be safely shut down and maintained in a safe shutdown condition in the event of a postulated rupture of a high- or moderate-energy piping system inside or outside of containment.

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.[39]

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.[40] Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.[41]

For protection against postulated pipe ruptures outside containment, Reference 2 includes the area of concern in this position and has been used for those plants for which construction permit applications were tendered before July 1, 1973. Reference 3 specifically emphasizes protection via plant arrangement and layouts utilizing the concept of physical separation to the extent practical and has been used for those plants for which construction permit applications were tendered after July 1, 1973, and before July 1, 1975, as specified in Section B.4 of BTP ~~ASB~~SPLB[42] 3-1. BTP EMEB[43] 3-1 has been used for all construction permit applications, in lieu of References 2 and 3, since July 1, 1975, and should be used for future applications.[44]

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and ~~Missile~~Dynamic Effects[45] Design Bases."

2. Attachment to letter from A. Giambusso, December 1972, "General Information Required for Consideration of the Effects of a Piping System Break Outside Containment," Appendix B to BTP ~~ASB~~SPLB[46] 3-1 (attached to SRP Section 3.6.1).

3. Letter from J. F. O'Leary, July 12, 1973, and attachment entitled, "Criteria for Determination of Postulated Break and Leakage Locations in High and Moderate Energy Fluid Piping Systems Outside of Containment Structures," Appendix C to BTP ~~ASB~~SPLB[47] 3-1 (attached to SRP Section 3.6.1).

4. Branch Technical Position EMEB[48] 3-1, "Postulated Rupture Locations in Fluid System Piping Inside And Outside Containment," attached to this SRP section.

5. Branch Technical Position ~~ASB~~SPLB[49] 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment" (attached to SRP Section 3.6.1).

6. F. J. Moody, "Prediction of Blowdown and Jet Thrust Forces," ASME Paper 69 HT-31, August 6, 1969.

7. NUREG-0609, "Asymmetric Blowdown Loads on PWR Primary Systems," resolution of Generic Task Action Plan A-2.

BRANCH TECHNICAL POSITION EMEB 3-1
(FORMERLY BTP MEB 3-1)[50]

POSTULATED RUPTURE LOCATIONS IN FLUID SYSTEM
PIPING INSIDE AND OUTSIDE CONTAINMENT

A. BACKGROUND

This position on pipe rupture postulation is intended to comply with the requirements of General Design Criteria 4 of Appendix A to 10 CFR Part 50 for the design of nuclear power plant structures and components. It is recognized that pipe rupture is a rare event which may only occur under unanticipated conditions, such as those which might be caused by possible design, construction, or operation errors; unanticipated loads; or unanticipated corrosive environments. Our observation of actual piping failures have indicated that they generally occur at high stress and fatigue locations, such as at the terminal ends of a piping system at its connection to the nozzles of a component. The rules of this position are intended to utilize the available piping design information by postulating pipe ruptures at locations having relatively higher potential for failure, such that an adequate and practical level of protection may be achieved.

Subject to certain limitations, General Design Criterion 4 allows dynamic effects associated with postulated pipe ruptures to be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate the probability of fluid system piping rupture is extremely low under design basis conditions. These analyses are commonly referred to as “leak-before-break” analyses. The application of leak-before-break to piping system design is reviewed in accordance with SRP Section 3.6.3 (later).[51]

In the ABWR and System 80+ design certification FSERs the Staff accepted an exemption to 10 CFR 100 Appendix A that the design of all safety-related SSCs consider OBE loads. In SECY 93-087 (Reference 4) the staff recommended that the Commission approve the approach to eliminate the OBE from the design of SSCs. Furthermore, the Staff concluded that no replacement earthquake loading should be used to establish the postulated pipe rupture and leakage crack locations once the OBE is eliminated from the design and that the criteria for postulating pipe ruptures and leakage cracks in high- and moderate-energy piping systems be based on factors attributed only to normal and operational transients. However, for establishing pipe breaks and leakage cracks due to fatigue effects, the Staff concluded that calculation of the cumulative usage factor should continue to include seismic cyclic effects.[52]

B. BRANCH TECHNICAL POSITION

1. High-Energy Fluid Systems Piping

   a. Fluid Systems Separated From Essential Systems and Components

      For the purpose of satisfying the separation provisions of plant arrangement as specified in B.1.a of Branch Technical Position (BTP) ~~ASB~~SPLB[53] 3-1, a review of the piping layout and plant arrangement drawings should clearly show the effects of postulated piping breaks at any location are isolated or physically remote from essential systems and components.[1] At the designer's option, break locations as determined from B.1.c of this position may be assumed for this purpose.

b. Fluid System Piping in Containment Penetration Areas

Breaks and cracks need not be postulated in those portions of piping from containment wall to and including the inboard or outboard isolation valves, provided they meet the requirements of the ASME Code, Section III, Subarticle NE-1120, and the following additional design requirements:

(1) The following design stress and fatigue limits should not be exceeded:

For ASME Code, Section III, Class 1 Piping

(a) The maximum stress range between any two load sets (including the zero load set) should not exceed 2.4 S_m and should be calculated[254] by Eq. (10) in ~~Paragraph~~[55] NB-3653, ASME Code, Section III~~, for those loads and conditions thereof for which level A and level B stress limits have been specified in the system's Design Specification, including an operating basis earthquake (OBE) event transient. The S_m is design stress intensity as defined in Article NB-3600 of the ASME Code Section III~~.[56]

If the calculated maximum stress range of Eq. (10) exceeds 2.4 S_m, the stress ranges calculated by both Eq. (12) and Eq. (13) in Paragraph NB-3653 should meet the limit of 2.4 S_m.

(b) The cumulative usage factor should be less than 0.1.

(c) The maximum stress, as calculated by Eq. (9) in ~~Paragraph~~[57] NB-3652 under the loadings resulting from a postulated piping failure beyond these, portions of piping should not exceed 2.25 S_m and 1.8 S_y,[58] except that following a failure outside containment, the pipe between the outboard isolation valve and the first restraint may be permitted higher stresses provided a plastic hinge is not formed and operability of the valves with such stresses is ~~assured~~ensured in accordance with the requirements specified in SRP Section 3.9.3. Primary loads include those which are deflection limited by whip restraints.

[1] Systems and components required to shut down the reactor and mitigate the consequences of a postulated pipe rupture without offsite power.

[2] For those loads and conditions in which Level A and Level B stress limits have been specified in the design specification (including the operating basis earthquake).

For ASME Code, Section III, Class 2 Piping

(d) The maximum stress ranges as calculated by the sum of Eqs.[59] (9) and (10) in Paragraph NC-365~~2~~3,[60] ASME Code, Section III, considering those loads and conditions thereof for which level A and level B stress limits have been specified in the system's design specification (i.e., sustained loads, occasional loads, and thermal expansion), including an OBE event should not exceed 0.8(~~1.2~~1.8[61] $S_h + S_A$). The S_h and S_A are allowable stresses at maximum (hot) temperature and allowable stress range for thermal expansion, respectively, as defined in Article NC-3600 of the ASME Code, Section III.

(e) The maximum stress, as calculated by Eq. (9) in Paragraph NC-365~~2~~3[62] under the loadings resulting from a postulated piping failure of fluid system piping beyond these portions of piping should not exceed ~~1.8 S_h~~2.25 S_h and 1.8 S_y.[63]

Primary loads include those which are deflection limited by whip restraints. The exceptions permitted in (c) above may also be applied, provided that when the piping between the outboard isolation valve and the restraint is constructed in accordance with the Power Piping Code ANSI B31.1 (see ASB 3-1, B.2.c(4)),[64] the piping shall either be of seamless construction with full radiography of all circumferential welds or all longitudinal and circumferential welds shall be fully radiographed.

(2) Welded attachments, for pipe supports or other purposes, to these portions of piping should be avoided, except where detailed stress analyses, or tests, are performed to demonstrate compliance with the limits of B.1.b(1).

(3) The number of circumferential and longitudinal piping welds and branch connections should be minimized. Where guard pipes are used, the enclosed portion of <u>fluid system</u> piping should be seamless construction and without circumferential welds unless specific access provisions are made to permit inservice volumetric examination of the longitudinal and circumferential welds.

(4) The length of these portions of piping should be reduced to the minimum length practical.

(5) The design of pipe anchors or restraints (e.g., connections to containment penetrations and pipe-whip restraints) should not require welding directly to the outer surface of the piping (e.g., flued integrally forged pipe fittings may be used), except where such welds are 100~~ percent~~%[65] volumetrically examinable in service and a detailed stress analysis is performed to demonstrate compliance with the limits of B.1.b(1).

(6) Guard pipes provided for those portions of piping in the containment penetration areas should be constructed in accordance with the rules of Class MC, Subsection NE of the ASME Code, Section III, where the guard pipe is part of the containment boundary. In addition, the entire

guard pipe assembly should be designed to meet the following requirements and tests:

(a) The design pressure and temperature should not be less than the maximum operating pressure and temperature of the enclosed pipe under normal plant conditions.

(b) The ~~design stress limits of Paragraph NE-3131(c)~~Level C stress limits in NE-3220, ASME Code, Section III,[66] should not be exceeded under the loading associated with containment design pressure and temperature in combination with the safe shutdown earthquake.

(c) Guard pipe assemblies should be subjected to a single pressure test at a pressure not less than its design pressure.

(d) Guard pipe assemblies should not prevent the access required to conduct the inservice examination specified in B.1.b.(7). Inspection ports, if used, should not be located in that portion of the guard pipe through the annulus of dual barrier containment structures.

(7) A 100% volumetric inservice examination of all pipe welds should be conducted during each inspection interval as defined in IWA-2400, ASME Code, Section XI.

c. Postulation of Pipe ~~Rupture~~Breaks[67] in Areas Other Than Containment Penetration

(1) With the exceptions of those portions of piping identified in B.1.b, breaks in Class 1 piping (ASME Code, Section III) should be postulated at the following locations in each piping and branch run:

(a) At terminal ends.[~~23~~68]

(b) At intermediate locations where the maximum stress range[~~4~~269] as calculated by Eq. (10) ~~and either (12) or (13)~~and either Eq. (12) or Eq. (13)[70] exceeds 2.4 S_m.

[~~23~~] Extremities of piping runs that connect to structures, components (e.g., vessels, pumps, valves), or pipe anchors that act as rigid constraints to piping motion and thermal expansion. A branch connection to a main piping run is a terminal end of the branch run, except where the branch run is classified as part of a main run in the stress analysis and is shown to have a significant effect on the main run behavior. In piping runs which are maintained pressurized during normal plant conditions for only a portion of the run (i.e., up to the first normally closed valve), a terminal end of such runs is the piping connection to this closed valve.

~~[4]Stress range under those loads and conditions thereof for which level A and level B stress limits have been specified in the system's Design Specification, including an OBE event per paragraph NB-3653 of the ASME Code, Section III.~~

(c) At intermediate locations where the cumulative usage factor exceeds 0.1.

~~(d) If two intermediate locations cannot be determined by (b) and (c) above, two highest stress locations[5] based on Eq. (10) should be selected. If the piping run has only one change or no change of direction, only one intermediate location should be postulated.~~[71]

[72]As a result of piping reanalysis, the highest stress locations may be shifted; however, the initially determined intermediate break locations need not be changed unless one of the following conditions exist:

(i) ~~Maximum stress ranges or cumulative usage factors exceed the threshold levels in (b) or (c) above.~~The dynamic effects from the new (as-built) intermediate break locations are not mitigated by the original pipe-whip restraints and jet shields.[73]

(ii) A change is required in pipe parameters such as major differences in pipe size, wall thickness, and routing.

~~(iii) Breaks at the new highest stress locations are significantly apart from the original locations and result in consequences to safety-related systems requiring additional safety protection.~~

~~In such conditions, the newly determined highest stress locations should be the intermediate break locations.~~[74]

(2) With the exceptions of those portions of piping identified in B.1.b, breaks in Class 2 and 3 piping (ASME Code, Section III) should be postulated at the following locations in those portions of each piping and branch run:

(a) At terminal ends.

(b) At intermediate locations selected by one of the following criteria:

(i) At each pipe fitting (e.g., elbow, tee, cross, flange, and nonstandard fitting), welded attachment, and valve. Where the piping contains no fittings, welded attachments, or valves, at one location at each extreme of the piping run adjacent to the protective structure.

(ii) ~~At each location where the stresses[4] exceed 0.8 (1.2 S_h + S_A) but at not less than two separated locations chosen on the basis of highest stress.[6] Where the piping consists of a straight run without fittings, welded attachment, or valves, and all stresses are below 0.8~~

~~[5]Stresses under those loads and conditions thereof for which level A and level B stress limits have been specified in the System's Design Specification, including an OBE event as calculated by Eq. (9) and (10), Paragraph NC/ND-3652 of the ASME Code, Section III.~~

~~[6]Select two locations with at least 10% difference in stress, or if stresses differ by less than 10%, two locations separated by a change of direction of the pipe run.~~

~~(1.2 S_h + S_A), a minimum of one location chosen on the basis of highest stress.~~At each location where stresses calculated[2] by the sum of Eqs. (9) and (10) in NC/ND-3653, ASME Code, Section III, exceed 0.8 times the sum of the stress limits given in NC/ND-3653.[75]

As a result of piping reanalysis, due to differences between the design configuration and the as-built configuration, the highest stress locations may be shifted; however, the initially determined intermediate break locations may be used unless ~~one of the appropriate conditions of B.1.c(1)(d) exist~~a redesign of the piping resulting in a change in pipe parameters (diameter, wall thickness, routing) is required, or the dynamic effects from the new (as-built) intermediate break locations are not mitigated by the original pipe-whip restraints and jet shields.[76]

(3) Breaks in seismically analyzed non-ASME Class piping are postulated according to the same requirements as for ASME Class 2 and 3 piping above.[4] ~~nonnuclear class piping should be postulated at the following locations in each piping or branch run:~~

~~(a) At terminal ends of the run if located adjacent to the protective structure.~~

~~(b) At each intermediate pipe fitting, welded attachment, and valve.~~[77]

(4) Applicable to (1), (2), and (3) above:

If a structure separates a high-energy line from an essential component, that separating structure should be designed to withstand the consequences of the pipe break in the high-energy line which produces the greatest effect at the structure irrespective of the fact that the above criteria might not require such a break location to be postulated.

(5) Safety-related equipment must be environmentally qualified in accordance with SRP Section 3.11. Required pipe ruptures and leakage cracks (whichever controls) must be included in the design bases for environmental qualification of electrical and mechanical equipment both inside and outside the containment.[78]

d. The designer should identify each piping run ~~he has~~[79] considered to postulate the break locations required by B.1.c above. In complex systems such as those containing arrangements of headers and parallel piping running between headers, the designer should identify and include all such piping within a designated run in order to postulate the number of breaks required by these criteria.

e. With the exceptions of those portions of piping identified in B.1.b, leakage cracks should be postulated ~~in ASME Code, Section III, Class 1 piping where the stress~~

[4] Note that, in addition, breaks in nonseismic (i.e., non-Category I) piping are to be taken into account as described in Section II.2.k, "Interaction of Other Piping with Category I Piping," of SRP Section 3.9.2.

~~range by Eq. (10) of Paragraph NB-3653 exceeds 1.2 S_m, and in Class 2 and 3 or nonsafety class piping where the stress by them sum of Eq. (9) and (10) of Paragraph NC/ND 3652 exceeds 0.4 (1.2 S^h + S_A). Nonsafety class piping which has not been evaluated to obtain similar stress information shall have cracks postulated at locations that result in the most severe environmental consequence.~~as follows:

(1) For ASME Code, Section III, Class 1 piping, at axial locations where the calculated stress range[2] by Eq. (10) in NB-3653 exceeds 1.2 S(m).

(2) For ASME Code, Section III, Class 2 and 3 or nonsafety-class (not ASME Class 1, 2, or 3) piping, at axial locations where the calculated stress[2] by the sum of Eqs. (9) and (10) in NC/ND-3653 exceeds 0.4 times the sum of the stress limits given in NC/ND-3653.

(3) Nonsafety-class piping that has not been evaluated to obtain stress information should have leakage cracks postulated at axial locations that produce the most severe environmental effects.[80]

2. Moderate-Energy Fluid System Piping

a. Fluid Systems Separated from Essential Systems and Components

For the purpose of satisfying the separation provisions of plant arrangement as specified in B.1.a of BTP ~~ASB~~SPLB[81] 3-1, a review of the piping layout and plant arrangement drawings should clearly show that the effects of through-wall leakage cracks at any location in piping designed to seismic and nonseismic standards are isolated or physically remote from essential systems and components.

b. Fluid System Piping in Containment Penetration Areas

Leakage cracks ~~need not be postulated in those portions of piping from containment wall to and including the inboard or outboard isolation valves provided they meet the requirements of the ASME Code, Section III, Subarticle NE-1120, and are designed such that the maximum stress range does not exceed 0.4 (1.2 S_h + S_A) for ASME Code, Section III, Class 2 piping.~~need not be postulated in those portions of piping from containment wall to and including the inboard or outboard isolation valves provided they meet the requirements of the ASME Code, Section III, NE-1120, and the stresses calculated[2] by the sum of Eqs. (9) and (10) in ASME Code, Section III, NC-3653 do not exceed 0.4 times the sum of the stress limits given in NC-3653.[82]

c. Fluid Systems in Areas Other Than Containment Penetration

~~(1) Through-wall leakage cracks should be postulated in fluid system piping located adjacent to structures, systems or components important to safety, except (1) where exempted by B.2.b and B.2.d, or (2) where the maximum stress range in these portions of Class 1 piping (ASME Code, Section III) is less than 1.2 S_m, and Class 2 or 3 or non-safety class piping is less than 0.4 (1.2 S_h + S_A). The cracks should be postulated to occur individually at locations that result in the maximum effects from fluid spraying and flooding, with the consequent hazards or environmental conditions developed.~~

~~(2) Through-wall leakage cracks should be postulated in fluid system piping designed to nonseismic standards as necessary to satisfy B.3.d of BTP ASB 3-1.~~

(1) Leakage cracks should be postulated in piping located adjacent to structures, systems, or components important to safety, except:

(a) Where exempted by B.2.b or B.2.d,

(b) For ASME Code, Section III, Class 1 piping, the stress range calculated[2] by Eq. (10) in NB-3653 is less than 1.2 S(m), and

(c) For ASME Code, Section III, Class 2 or 3 and nonsafety-class piping, the stresses calculated[2] by the sum of Eqs. (9) and (10) in NC/HD-3653 are less than 0.4 times the sum of the stress limits given in NC/ND-3653.

(2) Leakage cracks, unless the piping system is exempted by (1) above, should be postulated at axial and circumferential locations that result in the most severe environmental consequences.

(3) Leakage cracks should be postulated in fluid system piping designed to nonseismic standards as necessary to satisfy B.3.d of BTP SPLB 3-1.[83]

d. Moderate-Energy Fluid Systems in Proximity to High-Energy Fluid Systems

~~Cracks~~Leakage cracks need not be postulated in moderate-energy fluid system piping located in an area in which a break in high-energy fluid system piping is postulated, provided such leakage[84] cracks would not result in more limiting environmental conditions than the high-energy piping break. Where a postulated leakage crack in the moderate-energy fluid system piping results in more limiting environmental conditions than the break in proximate high-energy fluid system piping, the provisions of B.2.c should be applied.

e. Fluid Systems Qualifying as High-Energy or Moderate-Energy Systems

Through-wall leakage cracks instead of breaks may be postulated in the piping of those fluid systems that qualify as high-energy fluid systems for only short operational periods~~[6]~~ [5] [85] but qualify as moderate-energy fluid systems for the major operational period.

~~[6]~~~~An~~[5] The operational period is considered "short" if the fraction of time that the system operates within the pressure-temperature conditions specified for high-energy fluid systems is about 2%~~ percent~~ of the time that the system operates as a moderate-energy fluid system (e.g., systems such as the reactor decay heat removal system qualify as moderate-energy fluid systems; however, systems such as auxiliary feedwater systems operated during PWR reactor startup, hot standby, or shutdown qualify as high-energy fluid systems).

3. Type of Breaks and Leakage Cracks in Fluid System Piping

a. Circumferential Pipe Breaks

The following circumferential breaks should be postulated individually in high-energy fluid system piping at the locations specified in B.1 of this position:

(1) Circumferential breaks should be postulated in fluid system piping and branch runs exceeding a nominal pipe size of 1 inch, except where the maximum stress range~~[3,4]~~ [2] [86] exceeds the limits specified in B.1.c(1) and B.1.c(2), but the circumferential stress range is at least 1.5 times the axial stress range. Instrument lines, 1 inch and less nominal pipe or tubing size should meet the provisions of Regulatory Guide 1.11.

(2) Where break locations are selected without the benefit of stress calculations, breaks should be postulated at the piping welds to each fitting, valve, or welded attachment. ~~Alternatively, a single break location at the section of maximum stress range may be selected as determined by detailed stress analyses (e.g., finite element analyses) or tests on a pipe fitting.~~[87]

(3) Circumferential breaks should be assumed to result in pipe severance and separation amounting to at least a one-diameter lateral displacement of the ruptured piping sections unless physically limited by piping restraints, structural members, or piping stiffness as may be demonstrated by inelastic limit analysis (e.g., a plastic hinge in the piping is not developed under loading).

(4) The dynamic force of the jet discharge at the break location should be based on the effective cross-sectional flow area of the pipe and on a calculated fluid pressure as modified by an analytically or experimentally determined thrust coefficient. Limited pipe displacement at the break location, line restrictions, flow limiters, positive pump-controlled flow, and the absence of energy reservoirs may be taken into account, as applicable, in the reduction of jet discharge.

(5) Pipe whipping should be assumed to occur in the plane defined by the piping geometry and configuration and to initiate pipe movement in the direction of the jet reaction.

b. Longitudinal Pipe Breaks

The following longitudinal breaks should be postulated in high-energy fluid system piping at the locations of the circumferential breaks specified in B.3.a:

(1) Longitudinal breaks in fluid system piping and branch runs should be postulated in nominal pipe sizes 4-inch and larger, except where the maximum stress range[2] [88] exceeds the limits specified in B.1.c(1) and B.1.c(2), but the axial stress range is at least 1.5 times the circumferential stress range.

(2) Longitudinal breaks need not be postulated at terminal ends. ~~:~~

~~(a) Terminal ends.~~

(b) ~~At intermediate locations where the criterion for a minimum number of break locations must be satisfied.~~[89]

(3) Longitudinal breaks should be assumed to result in an axial split without pipe severance. Splits should be oriented (but not concurrently) at two diametrically opposed points on the piping circumference such that the jet reactions causes out-of-plant bending of the piping configuration. Alternatively, a single split may be assumed at the section of highest tensile stress as determined by detailed stress analysis (e.g., finite element analysis).

(4) The dynamic force of the fluid jet discharge should be based on a circular or elliptical (2D x ½D) break area equal to the effective cross-sectional flow area of the pipe at the break location and on a calculated fluid pressure modified by an analytically or experimentally determined thrust coefficient as determined for a circumferential break at the same location. Line restrictions, flow limiters, positive pump-controlled flow, and the absence of energy reservoirs may be taken into account, as applicable, in the reduction of jet discharge.

(5) Piping movement should be assumed to occur in the direction of the jet reaction unless limited by structural members, piping restraints, or piping stiffness as demonstrated by inelastic limit analysis.

c. ~~Through-Wall~~ Leakage Crack~~s~~

~~The following through-wall leakage cracks should be postulated in moderate energy fluid system piping at the locations specified in B.2 of this position.~~

~~(1) Cracks should be postulated in moderate-energy fluid system piping and branch runs exceeding a nominal pipe size of 1 inch. These cracks should be postulated individually at locations that result in the most severe environmental consequences.~~

~~(2) Fluid flow from a crack should be based on a circular opening of area equal to that of a rectangle one-half pipe-diameter in length and one-half pipe wall thickness in width.~~

Leakage cracks should be postulated at those axial locations specified in B.1.e for high-energy fluid system piping and in those piping systems not exempted in B.2.c(1) for moderate-energy fluid system piping.

(1) Leakage cracks need not be postulated in 1-inch and smaller piping.

(2) For high-energy fluid system piping, the leakage cracks should be postulated to be in those circumferential locations that result in the most severe environmental consequences. For moderate-energy fluid system piping, see B.2.c(2).

(3) Fluid flow from a leakage crack should be based on a circular opening of area equal to that of a rectangle one-half pipe diameter in length and one-half pipe wall thickness in width.

(~~3~~4) The flow from the leakage crack should be assumed to result in an environment that wets all unprotected components within the compartment, with consequent flooding in the compartment and communicating compartments. Flooding effects should be determined on the basis of a conservatively estimated time period required to effect corrective actions.[90]

C. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and ~~Missile~~Dynamic Effects Design ~~Basis~~Bases."[91]

2. "Boiler and Pressure Vessel Code," Section III and XI, American Society of Mechanical Engineers.[92]

3. Regulatory Guide 1.11, "Instrument Lines Penetrating Primary Reactor Containment."

4. SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," April 2, 1993; SRM-93-087 issued on July 21, 1993.

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SRP Draft Section 3.6.2

Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Primary review branch abbreviation	Changed "MEB" to "EMEB."
2.	Editorial	Provided "GDC 4" as initialism for "General Design Criterion 4," and deleted unnecessary reference callout.
3.	SRP-UDP format item	Deleted citation of reference number.
4.	Primary review branch abbreviation	Changed "MEB" to "EMEB."
5.	Editorial	Defined "SRP" as "Standard Review Plan."
6.	Editorial	Changed numbers to letters so that subsections will be uniquely labeled.
7.	Editorial	Substituted "ensure" for "assure."
8.	SRP-UDP format item	Added "Review Interfaces" subsection.
9.	Primary review branch abbreviation	Modified existing lead-in text and substituted current primary review branch abbreviation.
10.	SRP-UDP format item	Divided existing text into separate subsections and numbered them for clarification.
11.	Current review interface branch designation and abbreviation	Substituted "Plant Systems Branch (SPLB)" for "Auxiliary Systems Branch (ASB)."
12.	Current review interface branch abbreviation	Substituted "SPLB" for "ASB."
13.	**Integrated Impact 87**	Added a Review Interface with proposed SRP Section 3.6.3 regarding review of leak-before-break applications. The EMCB was selected as the primary review branch based on PRB comments received on ROC # 88.
14.	Current review interface branch designation and abbreviation	Substituted "Civil Engineering and Geosciences Branch (ECGB)" for "Structural Engineering Branch (SEB)."

Item	Source	Description
15.	Current review interface branch designation and abbreviation	Substituted "Civil Engineering and Geosciences Branch (ECGB)" for "Material Engineering Branch (MTEB)."
16.	Current review interface branch abbreviation	Substituted "SRXB" for "RSB."
17.	Current review interface branch abbreviation	Deleted "Equipment Qualification Branch (EQB)" and substituted "SPLB."
18.	Current review interface branch designation and abbreviation	Corrected the title to "The Containment Systems and Severe Accident Branch (SCSB)."
19.	Editorial	Simplified for clarity and readability.
20.	Primary review branch abbreviation	Changed "MEB" to "EMEB."
21.	Editorial	Initialism for "General Design Criterion 4" introduced in item 2 above.
22.	SRP-UDP format item/Current primary review branch abbreviation	Changed "MEB" to "EMEB." Deleted citation of the reference number because it is redundant.
23.	SRP-UDP format item	Changed "BTP MEB 3-1" to "BTP EMEB 3-1."
24.	Editorial	Changed word to "provides."
25.	SRP-UDP format item	Changed "BTP MEB 3-1" to "BTP EMEB 3-1."
26.	SRP-UDP format item	Added "Technical Rationale" subsection.
27.	SRP-UDP format item	Added introductory sentence to "Technical Rationale."
28.	SRP-UDP format item	Added technical rationale for GDC 4.
29.	SRP-UDP format item	Changed "BTP MEB 3-1" to "BTP EMEB 3-1."
30.	Editorial	Modified to improve clarity.
31.	Editorial	Placed border around figure and deleted cross-hatching under the curve in the figure. The intent of the cross-hatching was misleading.

Item	Source	Description
32.	Editorial	Placed border around figure and deleted cross-hatching under the curve (b) in the figure. The intent of the cross-hatching was misleading.
33.	Editorial	Added full designation of subsection for clarity.
34.	Editorial	Corrected "expand" to "expanded."
35.	Editorial	Defined "PWR" as "pressurized water reactor."
36.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
37.	Editorial	Deleted "his" and substituted "the" to eliminate gender-specific reference.
38.	Editorial	Provided "SER" as initialism for "safety evaluation report."
39.	SRP-UDP Format Item, Implement 10 CFR 52 Related Changes	To address design certification reviews a new paragraph was added to the end of the Evaluation Findings. This paragraph addresses design certification specific items including ITAAC, DAC, site interface requirements, and combined license action items.
40.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.
41.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
42.	SRP-UDP format item	Changed "ASB" to "SPLB" in the designation of the BTB.
43.	SRP-UDP format item	Changed "MEB" to "EMEB" in the designation of the BTB.
44.	SRP-UDP format item	Added endnote but made no change to the text. This paragraph includes information that is no longer applicable to new plant reviews. It was retained in order to provide background and preserve consistency with SRP Section 3.6.1.

Item	Source	Description
45.	SRP-UDP format item	Corrected title of GDC 4.
46.	SRP-UDP format item	Changed designation of Branch Technical Position (BTP) ASB 3-1 to BTP SPLB 3-1 in Reference 2.
47.	SRP-UDP format item	Changed designation of BTP ASB 3-1 to BTP SPLB 3-1 in Reference 3.
48.	SRP-UDP format item	Changed designation of BTP MEB 3-1 to BTP EMEB 3-1 in Reference 4.
49.	SRP-UDP format item	Changed designation of BTP ASB 3-1 to BTP SPLB 3-1 in Reference 5.
50.	SRP-UDP format item	Changed title to "EMEB" and added "(FORMERLY BTP MEB 3-1)."
51.	**Integrated Impact 87**	Added a paragraph to Branch Technical Position (BTP) MEB 3-1 to expand the background information on GDC 4 to include a discussion of leak-before-break, and identify that leak-before-break issues are reviewed as part of SRP Section 3.6.3 (to be developed).
52.	Integrated Impact No. 1344	Added a note to provide information regarding the exemption acceptance in the evolutionary FSERs allowing the elimination of OBE from design considerations.
53.	SRP-UDP format item	Changed designation of BTP ASB 3-1 to BTP SPLB 3-1.
54.	Integrated Impact No. 89	Added new footnote 2 in accordance with Revision 2 of BTP EMEB 3-1.
55.	Integrated Impact No. 89	Deleted the word "Paragraph" to conform to Revision 2 of BTP EMEB 3-1.
56.	Integrated Impact No. 89	Deleted text to conform to Revision 2 of BTP EMEB 3-1.
57.	Integrated Impact No. 89	Deleted the word "Paragraph" to conform to Revision 2 of BTP EMEB 3-1.
58.	Integrated Impact No. 89	Added a space after "2.25" and then added "and 1.8 Sy" to conform to Revision 2 of BTP EMEB 3-1.

Item	Source	Description
59.	Integrated Impact No. 89	Changed the abbreviation from "Eq." to "Eqs." to conform to Revision 2 of BTP EMEB 3-1.
60.	Editorial	Corrected paragraph number from "NC-3652" to "NC-3653."
61.	Integrated Impact No. 89	Changed "1.2" to "1.8" in the equation to conform to Revision 2 of BTP EMEB 3-1.
62.	Editorial	Corrected paragraph number from "NC-3652" to "NC-3653."
63.	Integrated Impact No. 89	Deleted "1.8 Sh" and substituted "2.25 Sh and 1.8 Sy" to conform to Revision 2 of BTP EMEB 3-1.
64.	Editorial	Added comma and closing-parenthesis.
65.	Editorial	Used percent sign for consistency within and between SRP sections (global change for this section).
66.	Integrated Impact No. 89	Deleted "design stress limits of Paragraph NE-3131(c)" and substituted "Level C stress limits in NE-3220, ASME Code, Section III" to conform to Revision 2 of BTP EMEB 3-1.
67.	Integrated Impact No. 89	Changed "Rupture" to "Breaks" in the title to conform to Revision 2 of BTP EMEB 3-1.
68.	Integrated Impact No. 89	Renumbered footnote to accommodate new footnote 2, which was added to conform to Revision 2 of BTP EMEB 3-1.
69.	Integrated Impact No. 89	Deleted existing footnote 4 to conform to Revision 2 of BTP EMEB 3-1. Cited footnote 2.
70.	Integrated Impact No. 89	Cited Eqs. (12) and (13) similar to original wording found in Revision 1 of Branch Technical Position (BTP) EMEB 3-1. This change is a correction that is documented in a NRC Memo from G. Bagchi to J. Norberg dated March 2, 1993, and in the second paragraph of subsection 3.6.2.1.2 of the CE80+ FSER (NUREG-1462).
71.	Integrated Impact No. 89	Deleted subsection B.1.c(1)(d), including existing footnote 5, to conform to Revision 2 of BTP EMEB 3-1.

Item	Source	Description
72.	Integrated Impact No. 89	Made the existing paragraph part of subsection B.1.c(1) to conform to Revision 2 of BTP EMEB 3-1.
73.	Integrated Impact No. 89	Deleted the existing subsection text and substituted the text from Revision 2 of BTP EMEB 3-1.
74.	Integrated Impact No. 89	Deleted existing subsection B.1.c(1)(d)(iii) and the sentence that follows to conform to Revision 2 of BTP EMEB 3-1.
75.	Integrated Impact No. 89	Deleted text of the first paragraph of the existing subsection B.1.c(2)(b)(ii), including existing footnote 6, and substituted text from Revision 2 of BTP EMEB 3-1.
76.	Integrated Impact No. 89	Revised text of the second paragraph of the existing subsection B.1.c(2)(b)(ii) to conform to Revision 2 of BTP EMEB 3-1.
77.	Integrated Impact No. 89	Revised text of subsection B.1.c(3) to conform to Revision 2 of Branch Technical Position (BTP) EMEB 3-1. Added new footnote 4.
78.	Integrated Impact No. 89	Added subsection B.1.c(5) to conform to Revision 2 of BTP EMEB 3-1.
79.	Editorial	Modified to eliminate gender-specific reference.
80.	Integrated Impact No. 89	Deleted text in subsection B.1.e and added subsections B.1.e(1), (2), and (3) to conform to Revision 2 of BTP EMEB 3-1.
81.	SRP-UDP format item	Changed "BTP ASB 3-1" to "BTP SPLB 3-1."
82.	SRP-UDP format item	Deleted existing text in subsection B.2.b and substituted new text in conformance with Revision 2 of BTP EMEB 3-1.
83.	Integrated Impact No. 89	Deleted existing text in subsection B.2.c and substituted new text in conformance with Revision 2 of BTP EMEB 3-1.
84.	Integrated Impact No. 89	Added the word "Leakage" (twice) in conformance with Revision 2 of BTP EMEB 3-1.

Item	Source	Description
85.	Integrated Impact No. 89	Changed "periods" to "period" and changed "An" to "The" in footnote 5 (previously footnote 6) in conformance with Revision 2 of BTP EMEB 3-1.
86.	Integrated Impact No. 89	Deleted citation of footnote 3 and 4 and cited footnote 2 in the sentence in conformance with Revision 2 of BTP EMEB 3-1.
87.	Integrated Impact No. 89	Deleted sentence in order to conform to Revision 2 of BTP EMEB 3-1.
88.	Integrated Impact No. 89	Added citation of footnote 2.
89.	Integrated Impact No. 89	Deleted subsections B.3.b(2)(a) and (b) and added "terminal ends" at the end of subsection B.3.b(2) to conform to Revision 2 of BTP EMEB 3-1.
90.	Integrated Impact No. 89	Revised subsection B.3.c completely to conform to Revision 2 of BTP EMEB 3-1.
91.	SRP-UDP format item	Corrected title of GDC 4.
92.	SRP-UDP format item	COMMENT WITHOUT CHANGE TO THE TEXT: Revision 2 of BTP MEB 3-1 indicates a change to cite the 1986 edition of the ASME Code. However, the latest version of the ASME Code cited in 10 CFR 50.55a is the 1989 edition. The version of the code should be omitted from the reference so that applicants can conform to the requirements cited in 10 CFR 50.55a without confusion.

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SRP Draft Section 3.6.2

Attachment B - Cross Reference of Integrated Impacts

Integrated Impact No.	Issue	SRP Subsections Affected
87	Modify SRP Section 3.6.2 to reflect change to GDC 4 to allow consideration of "leak before break" (LBB) pipe rupture criteria.	Added paragraph to Areas of Review, Review Interfaces. Added paragraph to BTP MEB 3-1, Section A.
88	Develop and issue SRP Section 3.6.3 regarding LBB evaluation procedures.	No change to SRP Section 3.6.2 is recommended based on Integrated Impact No. 88.
89	Replace Branch Technical Position EMEB 3-1, Revision 1, with Revision 2 in SRP Section 3.6.2. Modify Revision 2 in accordance with the latest staff position.	Revised Branch Technical Position (BTP) EMEB 3-1 (attached to SRP Section 3.6.2) throughout to incorporate the changes specified in Generic Letter 87-11 and the NRC Memorandum from G. Bagchi to J. Norberg, dated March 2, 1993.
90	Area of review in SRP Section 3.8.4 regarding the design effects of failure of masonry walls on high-energy piping.	No change to SRP Section 3.6.2 is recommended based on Integrated Impact No. 90.
91	Include ANSI/ANS-58.2 as an applicable industry standard in SRP Section 3.6.2	No change to SRP Section 3.6.2 is recommended based on Integrated Impact No. 91.
647	Cite the date of ASME B31.1 in SRP Section 3.6.2	No change to SRP Section 3.6.2 is recommended based on Integrated Impact No. 647.
1344	Eliminate citation of the operating basis earthquake in SRP Section 3.6.2	Branch Technical Position EMEB 3-1: Footnote 2 in subsection B.1.(b)(1)(a) subsection B.1.b(1)(d)